Project Report: Microbial Mat Communities

Project Investigator: ***David Stahl***

Project Progress

We continued to characterize microbial populations in two extreme systems: microbial mats inhabiting hypersaline evaporation ponds (Guerrero Negro, Baja California , Mexico) and associated with hot springs (Yellowstone National Park (YNP)). Mat population structure was characterized at two spatial scales using PCR–amplified ribosomal rRNA genes: horizontally, over distances up to a kilometer, and vertically at submillimetric scales. Although distribution of dominant populations was stable across large distances (~500m), some variation was observed at fine vertical scales (mm). Diel migration was revealed by significant variation between night/day population profiles, suggesting that some sulfide–oxidizing bacteria may enter the overlying water column at night when oxygen becomes limiting. Parallel analyses of greenhouse mats (with and without sulfate) maintained by members of the EMERG group at NASA Ames revealed few changes in population structure associated with sulfate limitation. However, significant differences were detected between rooftop and field mats. In particular, dominant phototrophs shifted from cyanobacteria to sulfur bacteria, regardless of sulfate treatment.

In Yellowstone, we focused on the enrichment and isolation of thermophilic sulfate reducing prokaryotes (SRP) from three hot springs using a variety of electron donors (organic or hydrogen) at 60°C or 80°C, identifying novel populations by sequencing of ^{16}S rRNA and dissimilatory sulfate reductase (DSR) genes. Sulfide production was observed at 60°C on all substrates. In contrast, sulfide was produced only at 80°C on hydrogen, either autotrophically or with acetate as an alternative carbon source. Sulfide was also produced in enrichments on hydrogen using sulfur, sulfite, or thiosulfate as the electron acceptors, at both 60°C and 80°C. In agreement with the observed lower metabolic diversity at higher temperatures, microscopic analysis of these enrichments revealed a lower number of morphotypes at 80°C than at 60°C. The observation that only hydrogen, among the various electron donors tested, supported the growth of SRP at 80°C argues for the importance of lithotrophic metabolism in these hydrothermal systems.

Highlights

- Sulfur cycle microbes track daily changes in redox boundary in a photosynthetic microbial mat.
- Reduced sulfate levels corresponding to phenotypic decreases in rates of sulfur metabolism do not result in significant genotypic changes in a hypersaline microbial mat community.
- Hydrogenotrophic autotrophs dominate in YNP high temperature hot springs.

Roadmap Objectives

- ***Objective No. 3.2:*** Origins and evolution of functional biomolecules
- ***Objective No. 3.3:*** Origins of energy transduction
- ***Objective No. 4.1:*** Earth's early biosphere
- ***Objective No. 4.2:*** Foundations of complex life
- ***Objective No. 5.1:*** Environment–dependent, molecular evolution in microorganisms
- ***Objective No. 5.2:*** Co–evolution of microbial communities
- ***Objective No. 5.3:*** Biochemical adaptation to extreme environments
- ***Objective No. 6.1:*** Environmental changes and the cycling of elements by the biota, communities, and ecosystems

Field Expeditions

Field Trip Name: Yellowstone National Park

Start Date: 9/2/2003	***End Date:*** 9/14/2003
Continent: North America	***Country:*** USA
State/Province: Wyoming	***Nearest City/Town:*** West Yellowstone, MT
Latitude:	***Longitude:***
Name of site(cave, mine, e.g.):	***Keywords:*** sulfate reduction

Description of Work: Measurement of endogenous sulfate reduction rates in Yellowstone hot springs. Laboratory cultivation of novel thermophilic sulfate–reducing microorganisms.

Members Involved:

Cross Team Collaborations

Received microbial mat samples from the EMERG research group at NASA Ames (Brad Bebout). Analyzed microbial community structure in mcrobial mats maintained under different sulfate concentrations.